



Royal Netherlands
Meteorological Institute
*Ministry of Infrastructure and the
Environment*

Retrieval of Aerosol Height with TROPOMI

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&

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TROPOMI L2 Algorithm Team



Overview

- Introduction of the aerosol height product
- Sensitivity analyses:
 - phase function
 - single scattering albedo



TROPOMI aerosol products

**Absorbing
Aerosol
Index**

**Aerosol
Layer
Height**

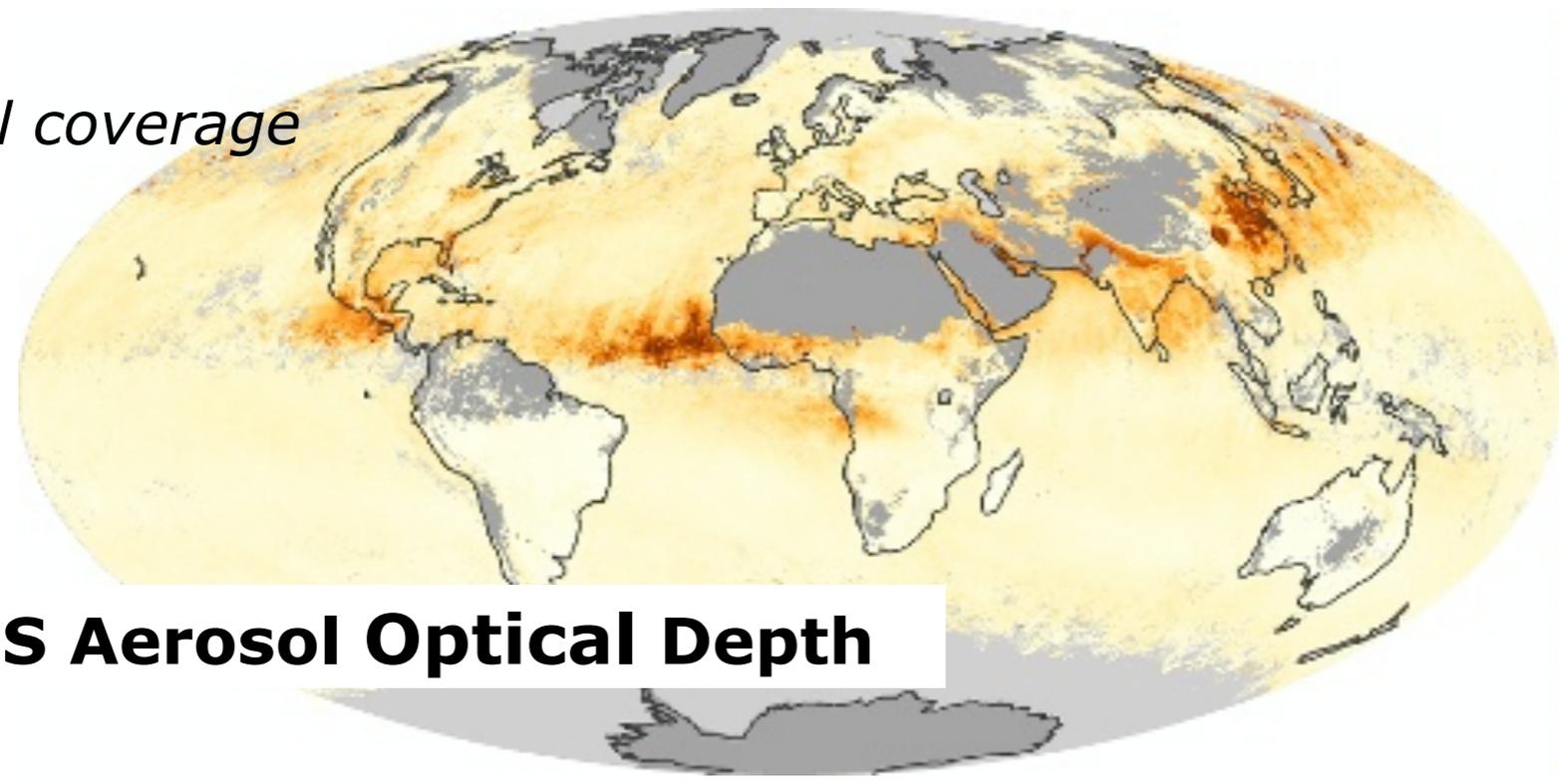
**Aerosol
Optical
Thickness
& Type**



TROPOMI: Daily global coverage



global coverage



MODIS Aerosol Optical Depth

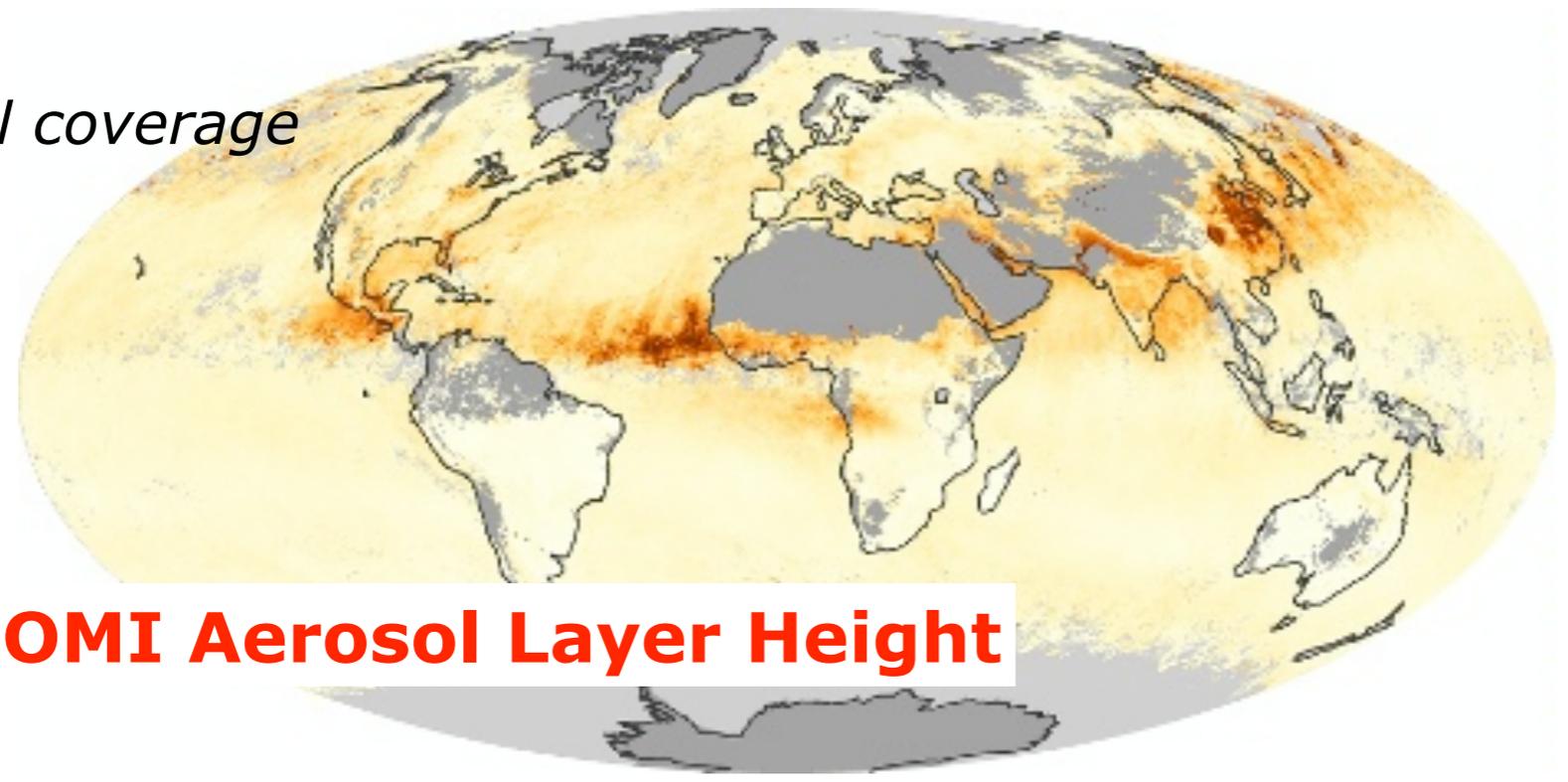
TROPOMI:
spatial resolution
of 7 km x 7 km



TROPOMI: Daily global coverage



global coverage

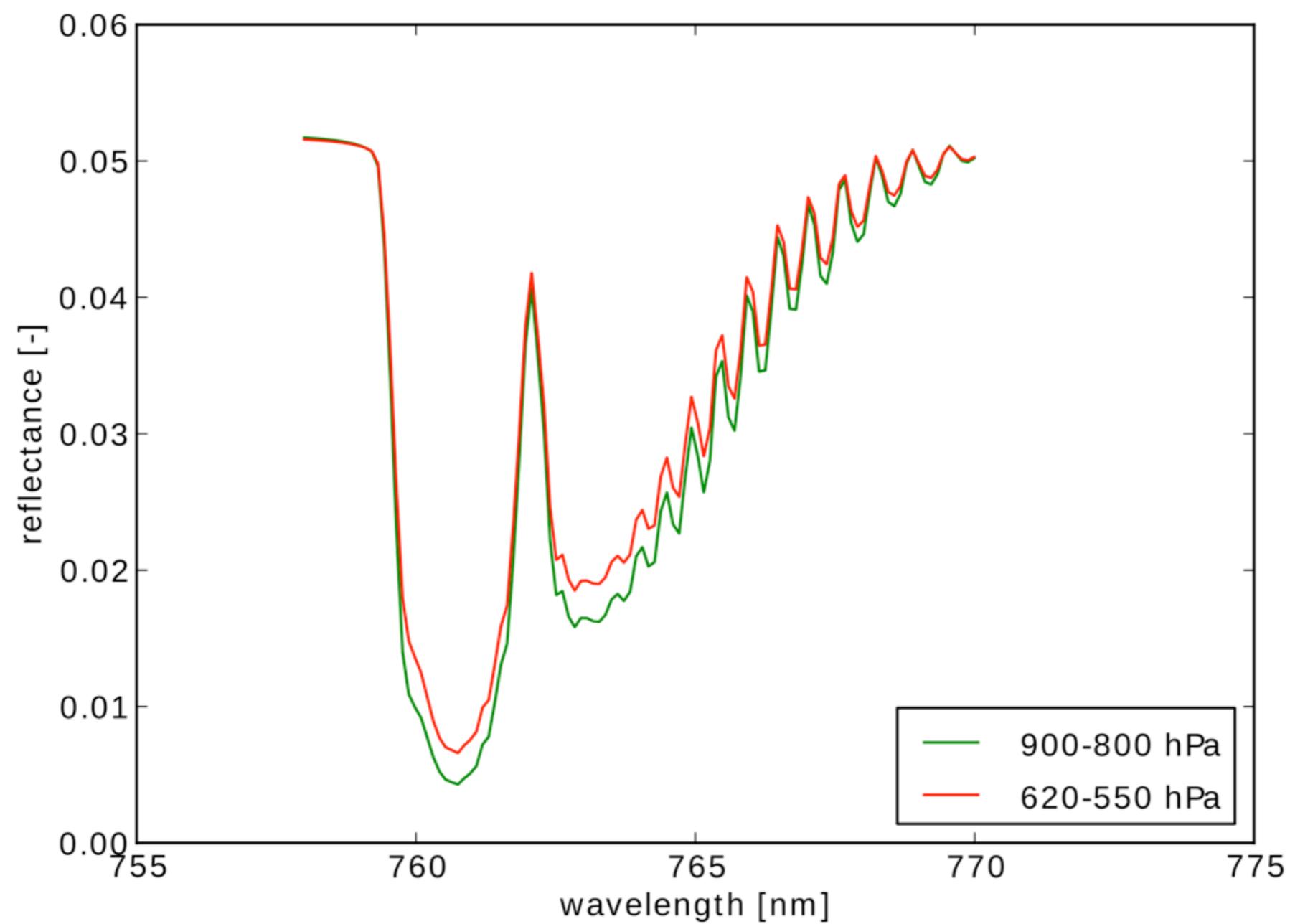


TROPOMI Aerosol Layer Height

TROPOMI:
spatial resolution
of 7 km x 7 km



Height retrieval using O₂ A-band



TROPOMI:
spectral
resolution
of 0.5 nm



Operational Aerosol Height Retrieval

- Spectral fit of reflectance at wavelengths $\sim 758-770$ nm:
fit parameters are ALH, AOT, A_s , ...
- Optimal Estimation: proper error analysis
- Further improvements in forward model:
P-T profiles, spectroscopic data, fluorescence...



DISAMAR --- J.F. de Haan

Determining Instrument Specifications and Analyzing Methods for Atmospheric Retrieval

Software package that can

- simulate *measured* backscattered radiances and
- apply different types of retrieval algorithms.

Used to investigate the sensitivity of L2 products to

- the forward model,
- the retrieval method and
- measurement errors.



Central Question

How well do we need to know the particular aerosol optical properties in order to retrieve its height accurately and precisely enough?



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Target science requirement of 50 hPa (0.5 km)

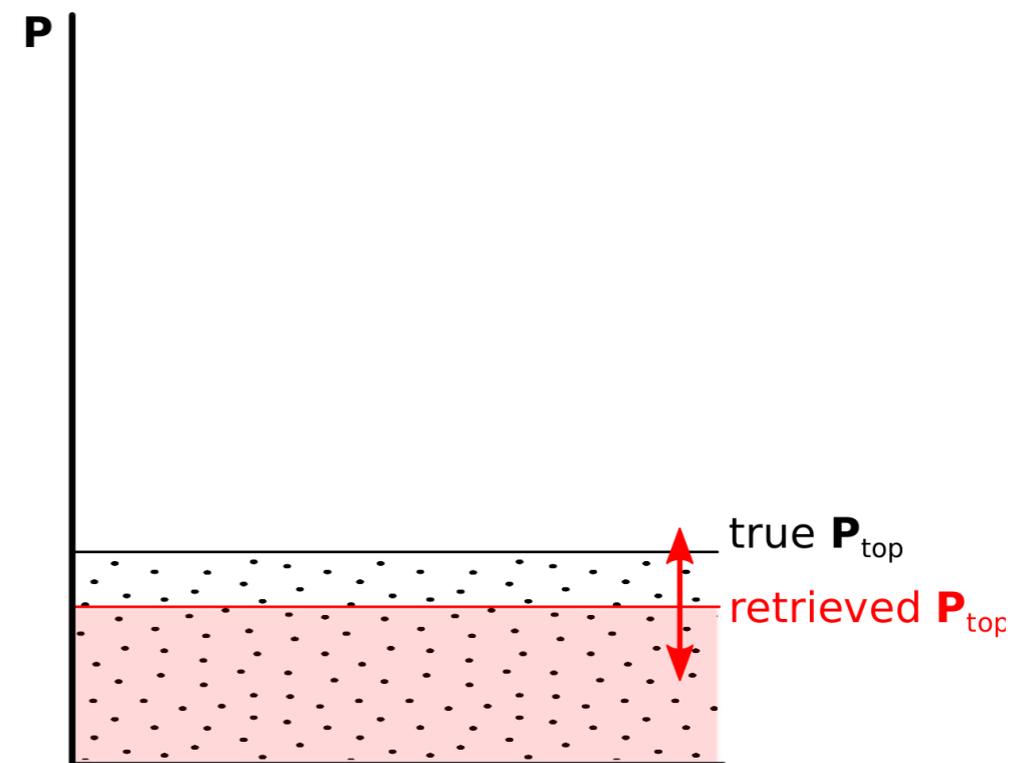
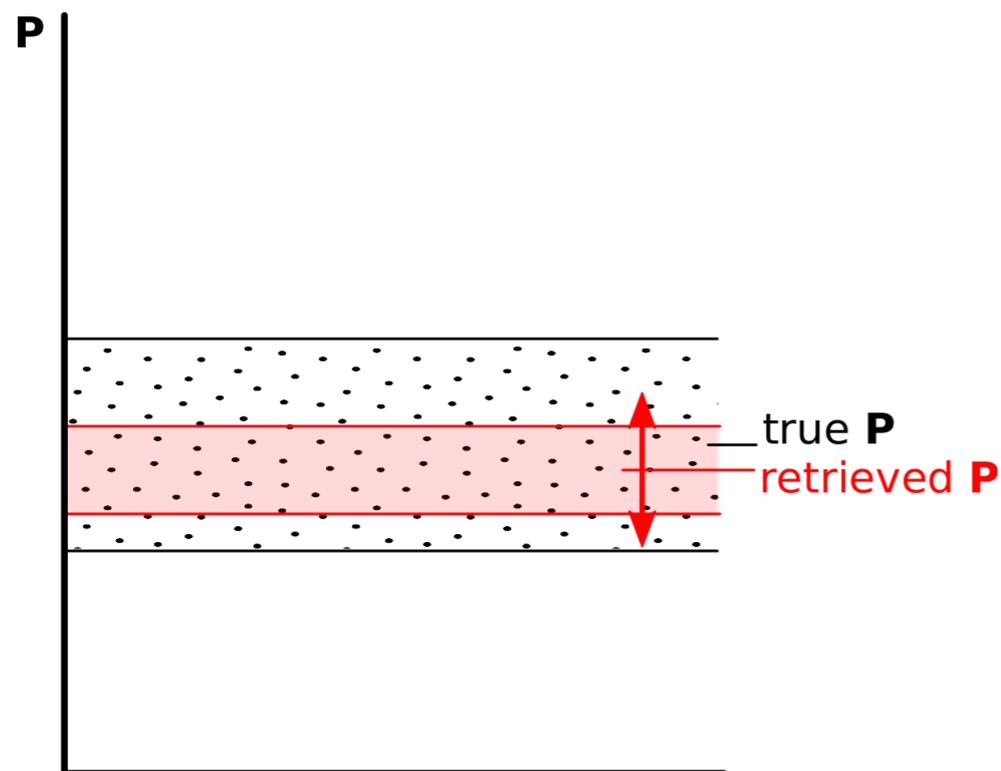


Sensitivity analysis: Phase function

true: phase function from Mie calculations
retrieval: Henyey-Greenstein phase function

(i) Dust over dark sea

(ii) Weakly absorbing over bright land



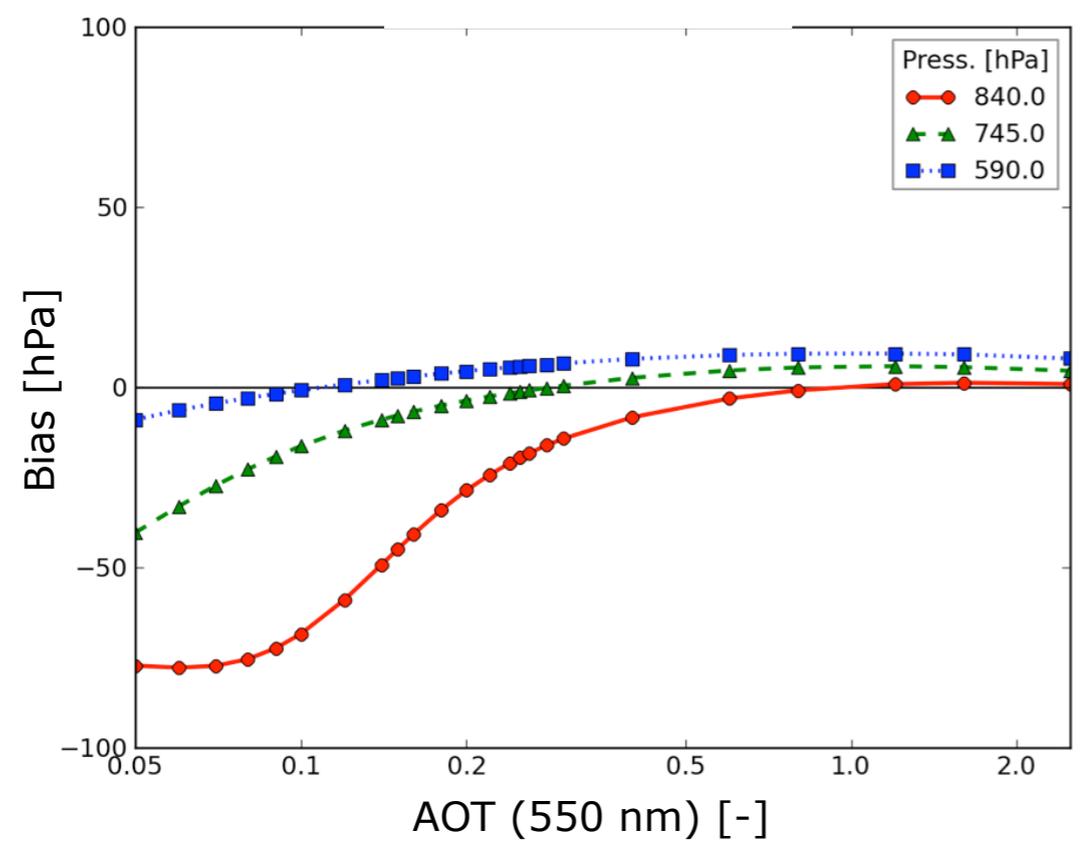
(aerosol models from *Aerosol Climate Change Initiative*-project)



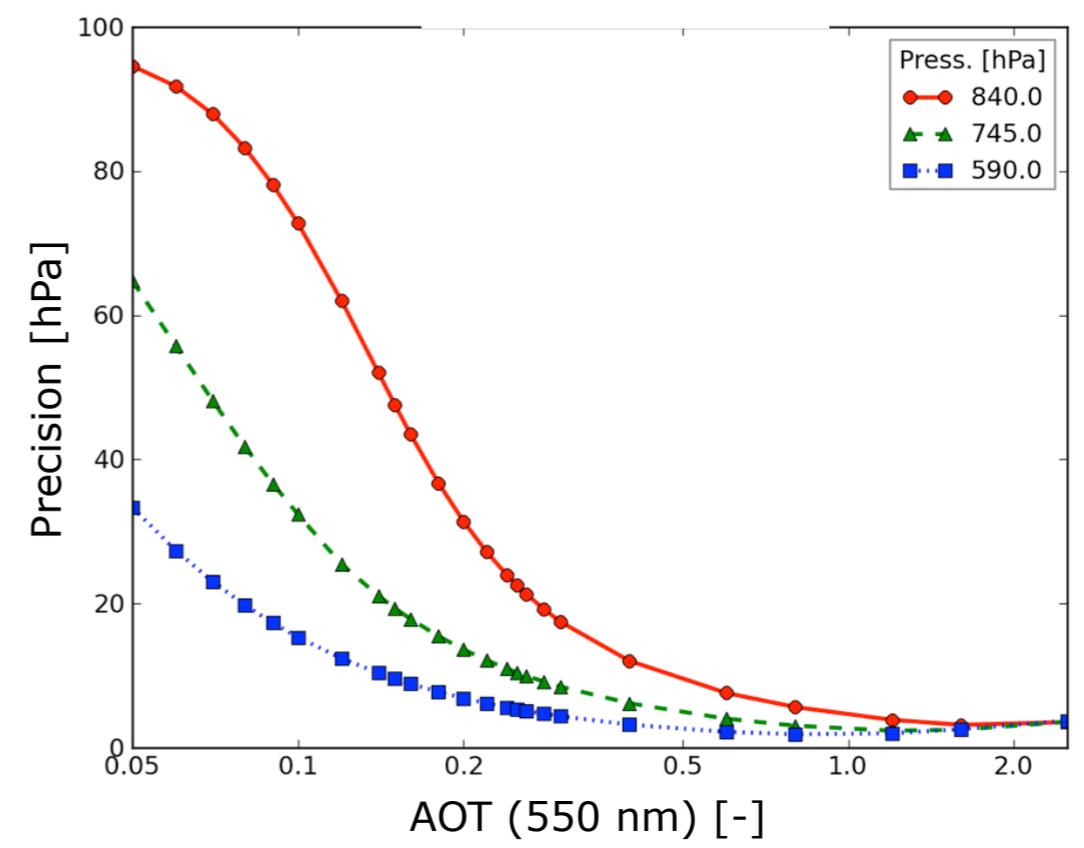
Dust over sea

fit: **P**, **AOT**, **SSA**, **A_s**

Bias (retrieved - true)



Precision (σ)

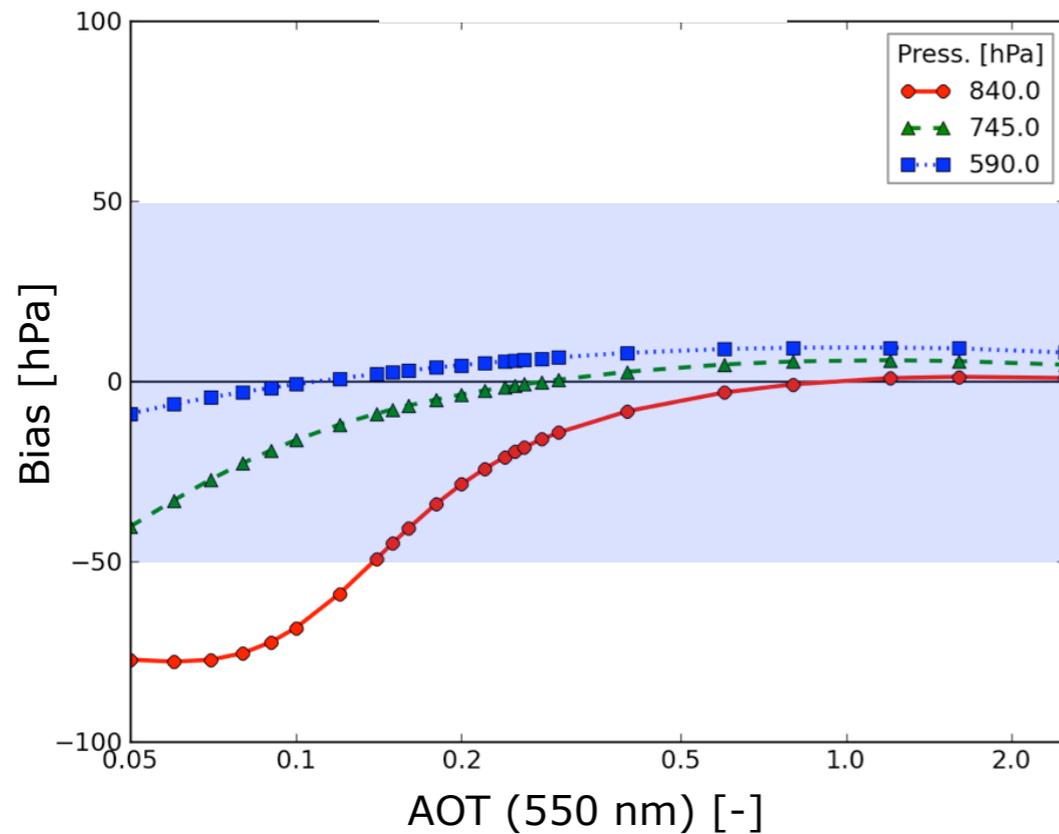




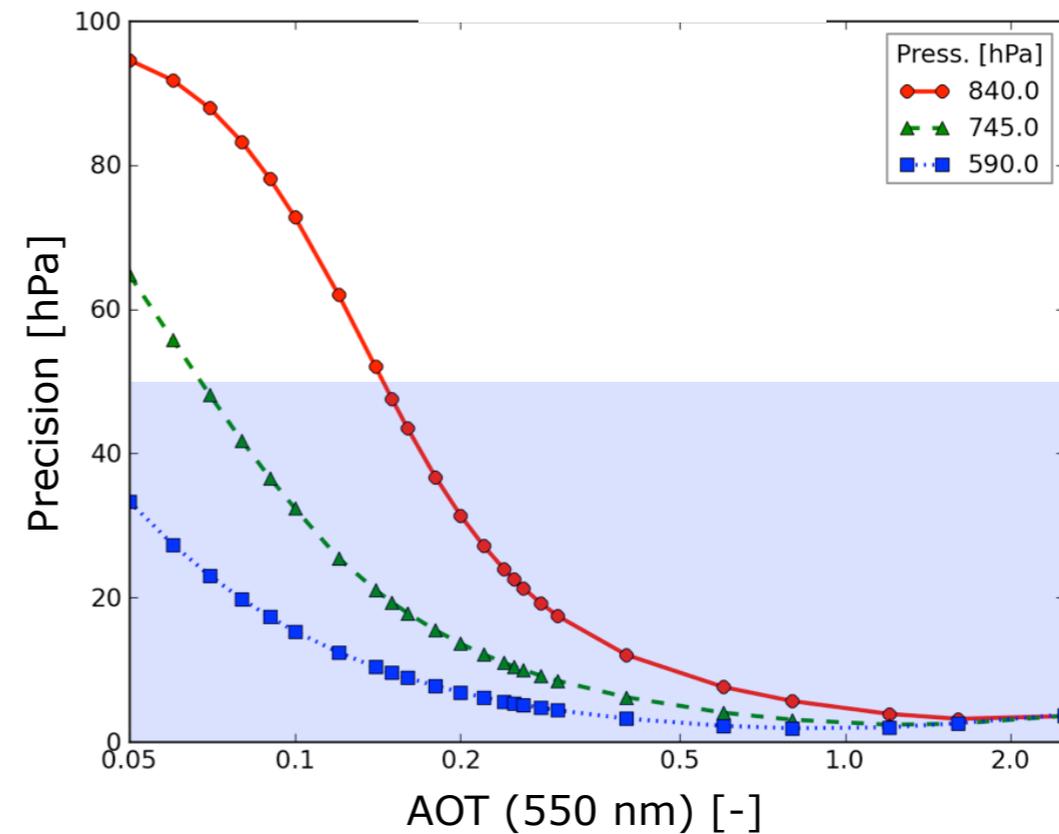
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Bias (retrieved - true)



Precision (σ)



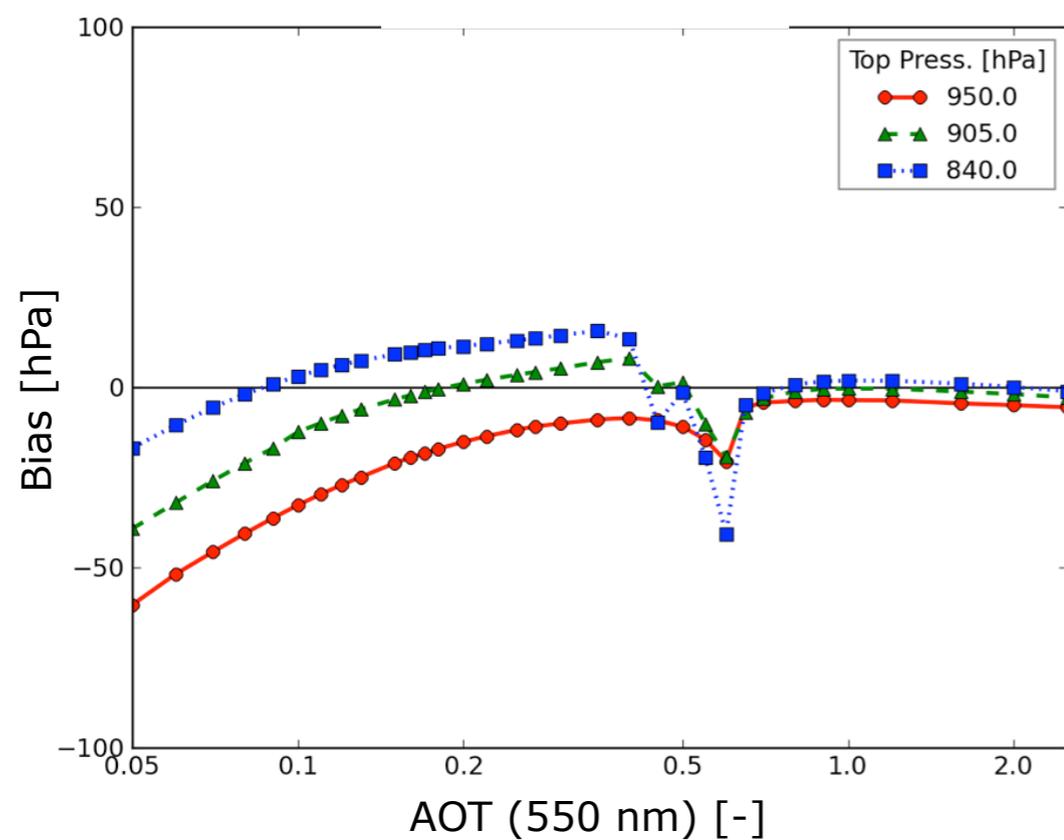
→ For AOT > 0.1-0.2, accuracy and precision of retrieved height below 50 hPa (500 m).



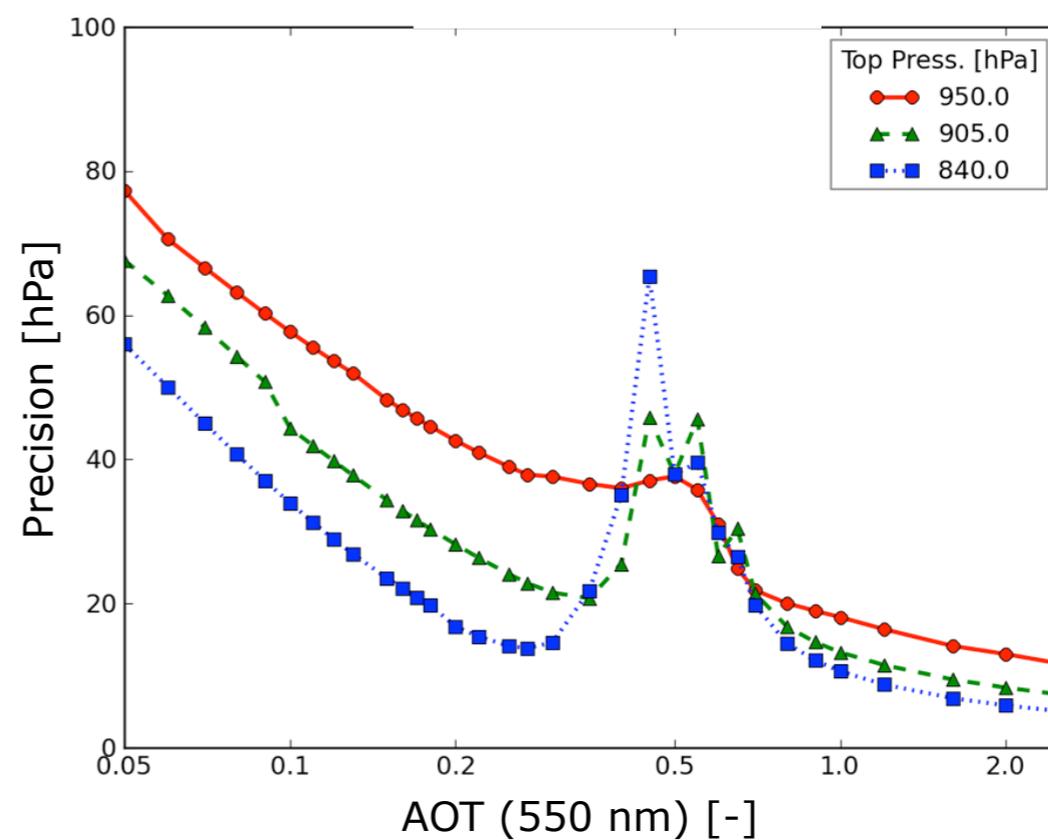
Weakly absorbing over land

fit: **P**, **AOT**, **A_s**

Bias (retrieved - true)



Precision (σ)

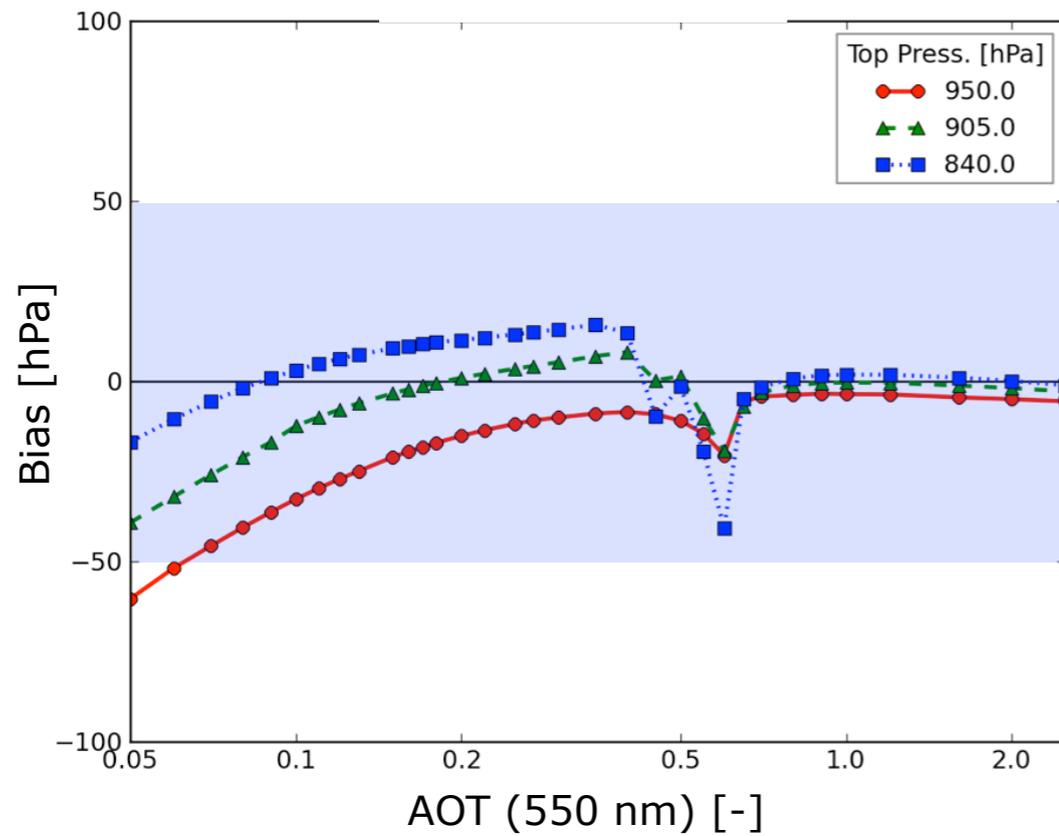




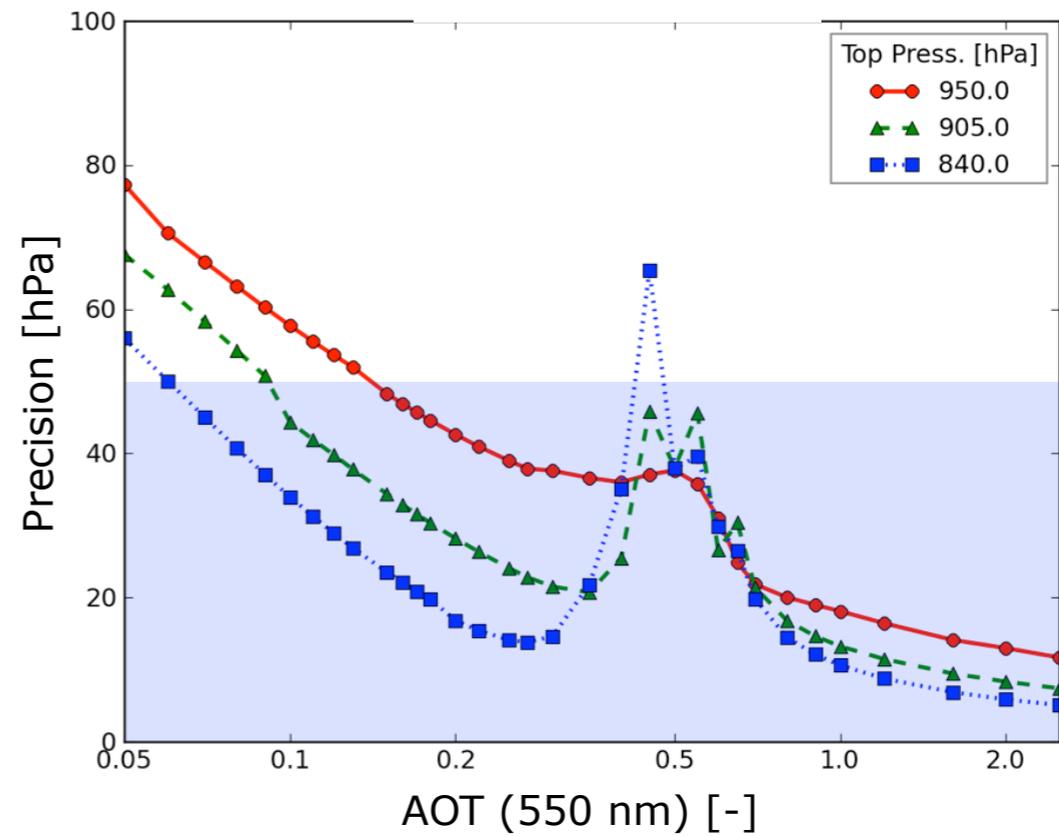
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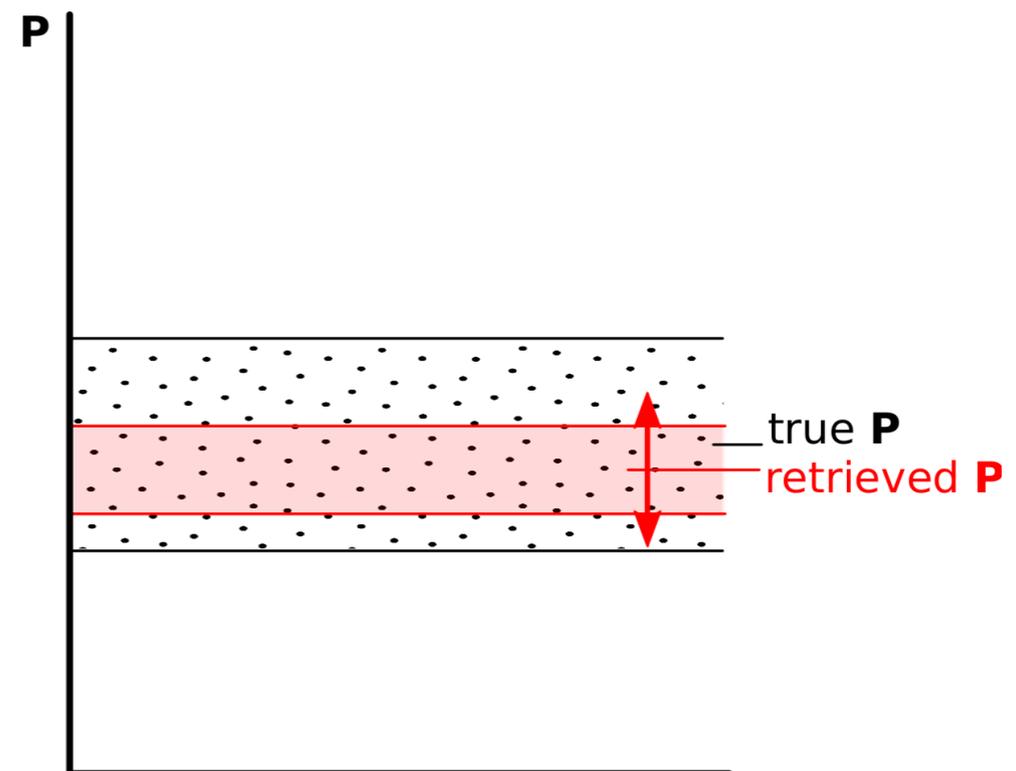


Sensitivity analysis: Single Scattering Albedo

true: SSA 0.90 or 1.0
retrieval: SSA 0.95

Same HG phase function in simulation and retrieval (g 0.7)

Dark sea surface

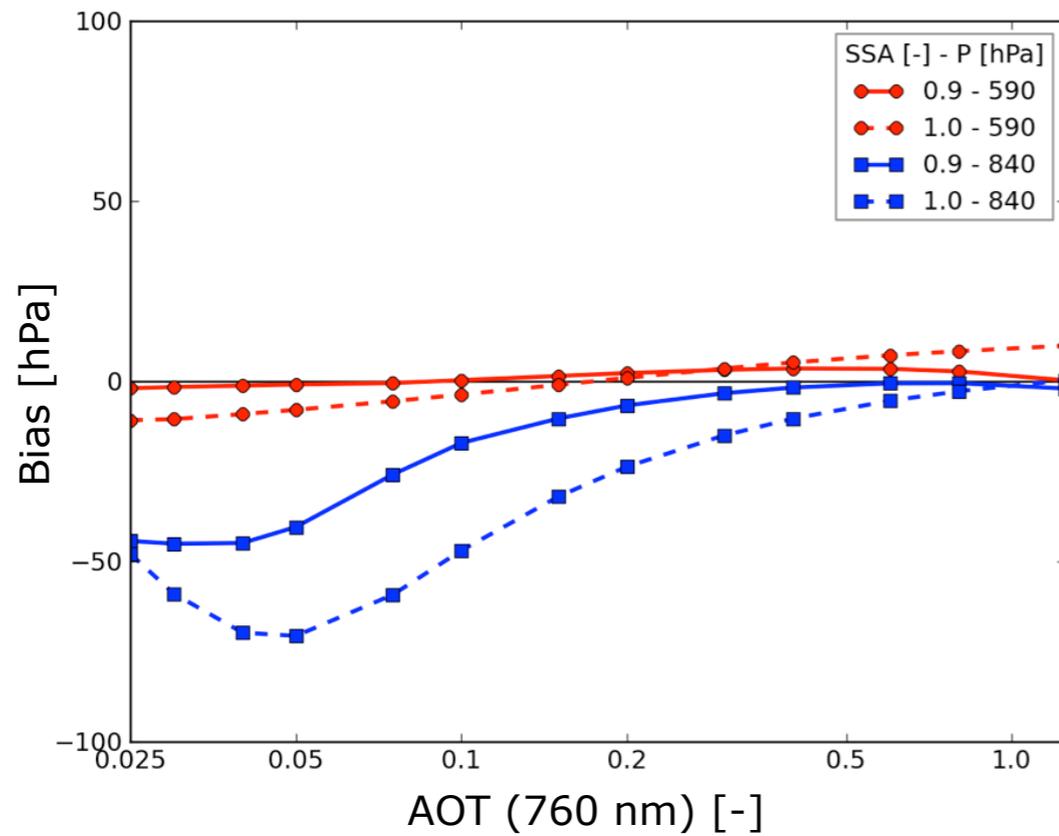




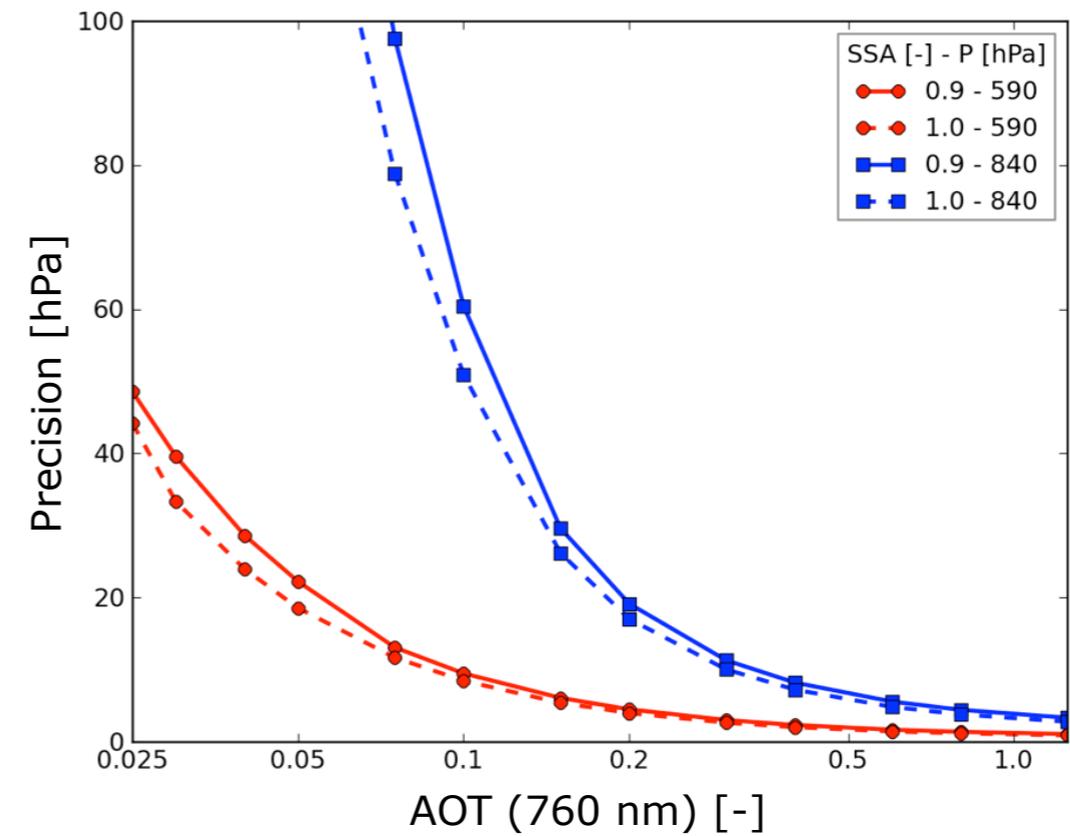
Single scattering albedo

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Precision (σ)

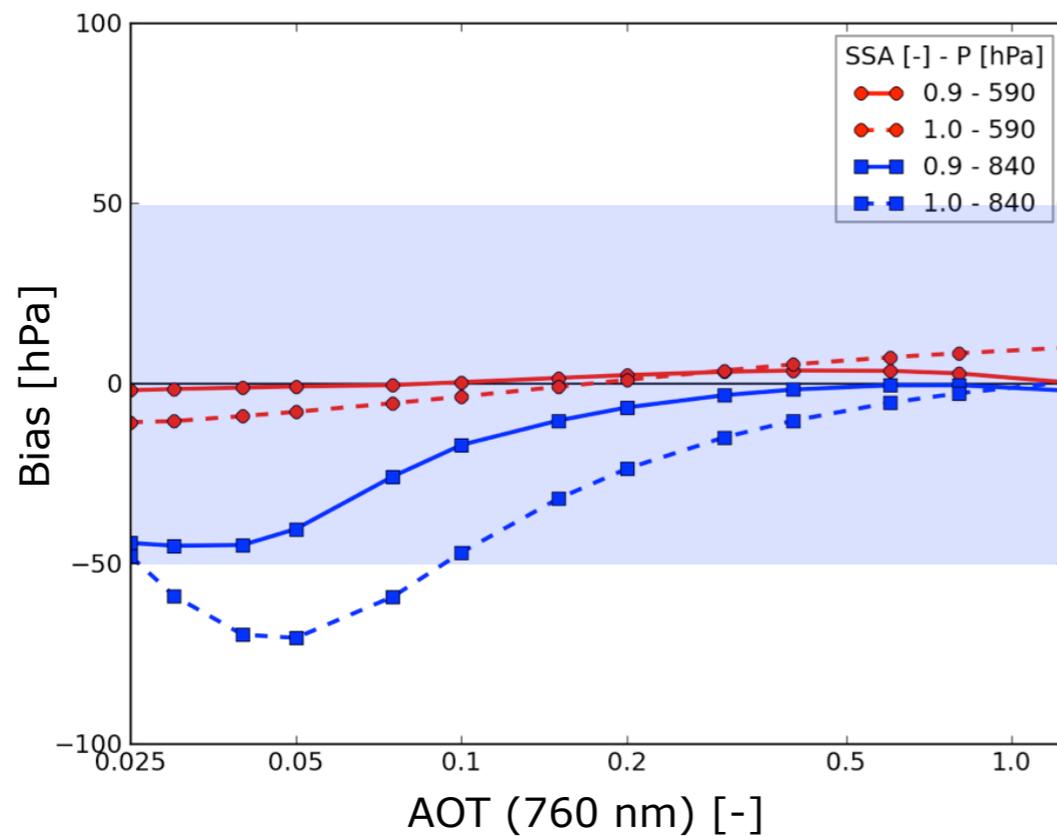




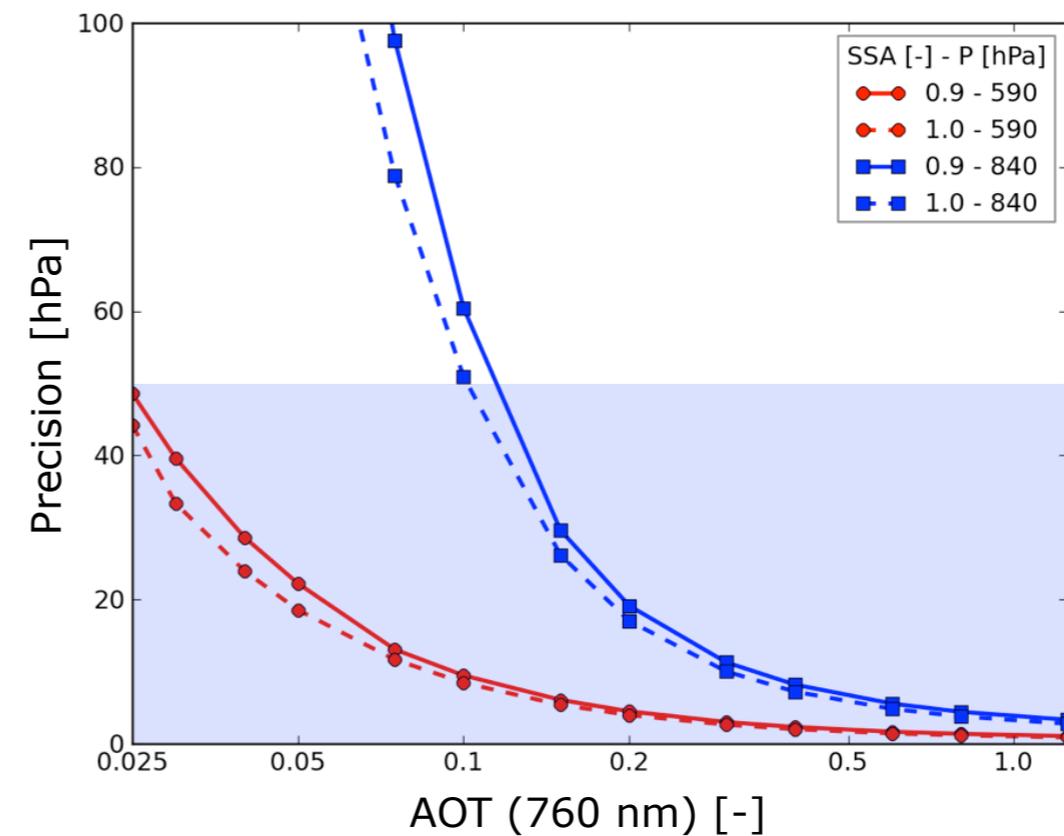
Single scattering albedo

fit: **P**, **AOT**, **A_s**

Bias (retrieved - true)



Precision (σ)



→ For AOT (760 nm) > ~0.1, accuracy and precision of retrieved height below 50 hPa (500 m).



Conclusions

- Accuracy and precision of retrieved height below ~ 50 hPa (.5 km) for aerosol layers with AOTs larger than 0.2, particularly for elevated layers.
- Henyey-Greenstein phase function can be used for faster retrieval.
- Retrieval robust against inaccurate knowledge of the SSA.

Future work

- Computation time & Convergence
- Cirrus contamination